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(58) Field of search
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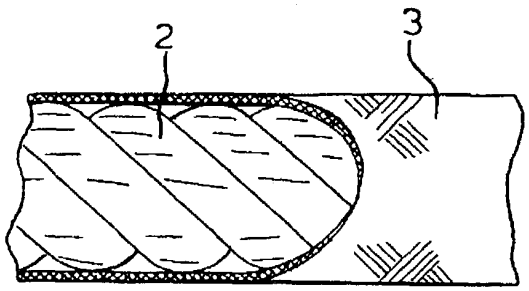
(54) An electrical cable

(57) An electrical cable comprises a plurality of strands 2 of electrically conductive metal wire having an outer sheath 3 of metal wire which holds the strands closely together while allowing the cable to flex under an imposed load. The wire of the strands and the sheath are preferably of copper and have the same the diameter.

A metal sleeve 5 is swaged or crimped to the end of the cable and a metal termination 6 joined to the sleeve by swaging or soldering.

The cable is used in the welding head of a welding robot.

FIG. 1.



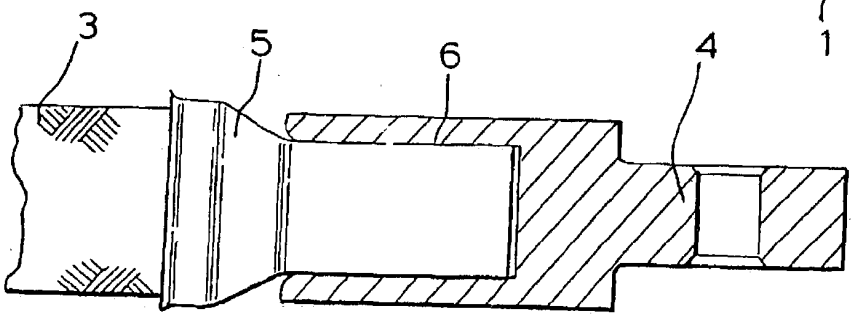


FIG. 3.

The drawing(s) originally filed was (were) informal and the print here reproduced is taken from a later filed formal copy.

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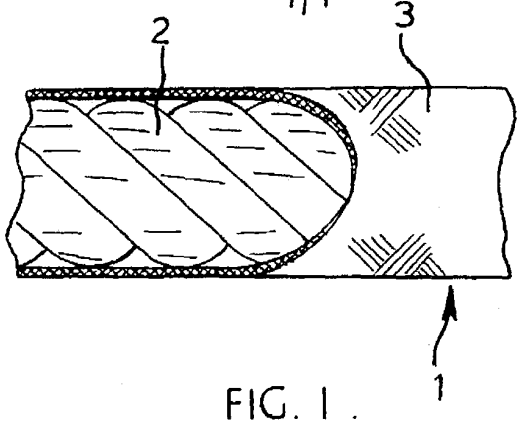

FIG. 1.

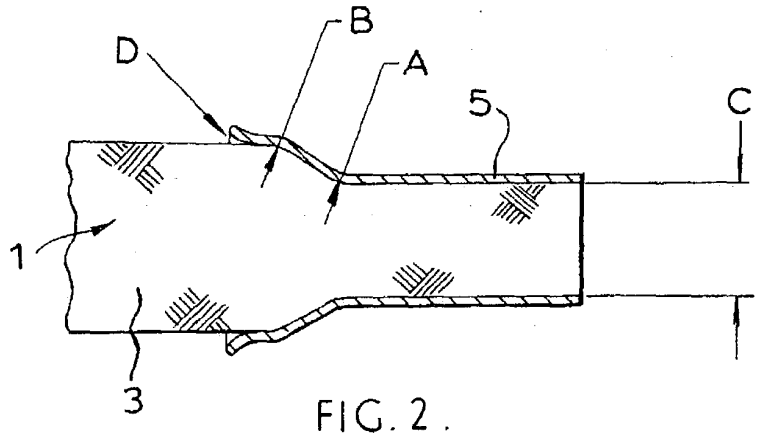

FIG. 2.

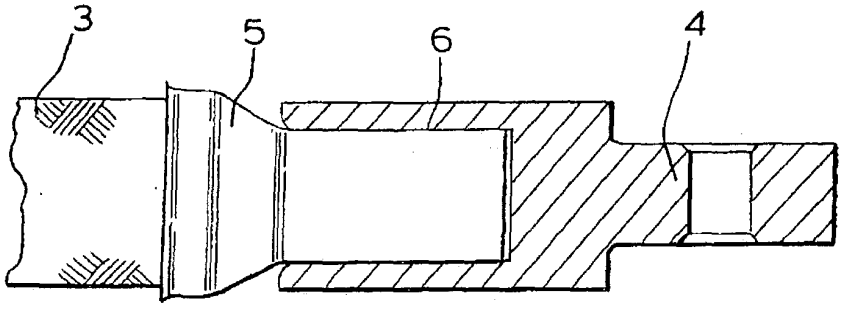

FIG. 3.

SPECIFICATION

An electrical connector

Technical field of invention

The invention relates to an electrical connector, and to a method of terminating same, which connectors are highly flexible and for carrying a high electrical current.

The need for highly flexible low force to bend high current cables has become particularly important since the widespread adoption of welding robots in high volume manufacturing industries, as the rapidly moving welding heads of the robots require electrical connectors or connections that do not restrict the movement of the welding heads.

A solution to this need has been to make the electrical connecting cables or connectors from multiple strands of fine copper wire laid up in a rope-lay configuration. This type of cable gives the required flexibility and low force to bend but, owing to a combination of high inertial loads that result from the rapid changes of movement of the welding head, and cable distorting loads that result from the rapid switching on and off of the electrical current, the cables generally last only a very short time.

Disclosure of invention

It is an object of the invention to seek to mitigate these disadvantages of the prior art.

According to a first aspect of the invention there is provided an electrical connector comprising a plurality of individual strands of electrically conductive metal wire laid up in a desired configuration to form a cable and an outer sheath of metal wire which holds the strands of the cable closely together while allowing the cable to flex under an imposed load.

Using the invention it is possible to provide a connector in which the sheath does not affect detrimentally the bend radius or force required to bend the cable and in which the wires of the cable are nevertheless held closely together, thereby making it possible for the cable to react as a single entity to imposed mechanical loads rather than as individual wires which would soon rupture if the sheath was not present. This constraining of the cable thus increase the life of the connector under flexure.

The desired configuration may comprise a rope-lay configuration. This provides a relatively simple way of forming the individual wires into an electrically conductive cable.

The sheath may be a braid of woven wires. This construction is relatively easy to make, by interweaving the wires of the sheath, while ensuring that the cable is constrained.

The individual wires of the cable and the individual wires of the sheath may each have substantially the same diameter. This providing for a relatively inexpensive instruction in which a uniform or standard diameter of wire may be used.

The metal wire of the cable and of the sheath may be copper wire. This provides for good electrical conductivity.

According to a second aspect of the invention there is provided a method of terminating an electrical connector as hereinbefore defined, comprising the steps of securing a sleeve mechanically to the connector at the end to be terminated without the use of heat, and then connecting the sleeve with the cable secured to it to an end termination.

The step of securing the sleeve and connector may be by swaging, which step provides a positive mechanical connection without the use of heat.

The step of connecting the sleeve with the end termination may comprise inserting the sleeve in a socket of the end termination, and then securing the sleeve and end termination together by use of solder or the like, or by swaging. These alternative methods comprise relatively simple yet effective means for effecting a positive electrical and mechanical connection with an end termination.

According to a third aspect of the invention there is provide a welding head such as a robot welding head including an electrical connector as hereinbefore defined or terminated in a method as hereinbefore defined.

An electrical connector embodying the invention is hereinafter describe by way of example, with reference to the accompanying drawings.

Brief description of drawings

Figure 1 is side elevational, part sectional, view of an electrical connector according to the invention;

Figure 2 is a side elevational, part sectional, view of an end of the connector of Figure 1 during a first step in a method of terminating same; and

Figure 3 is a side elevational, part sectional, view of an end of the connector of Figure 2 during a second step in a method of terminating same.

Referring to the drawings, in which like parts are referred to by like reference numerals, there is shown in Figure 1 an electrical connector 1 for a robot welding head (not shown) comprising a plurality of strands of copper wire laid up in a rope-lay configuration to form a cable 2 which is constrained within an outer sheath of copper wire which is woven to form a braid 3. The individual copper wires of the cable 2 and braid 3 are of substantially the same diameter.

Although only one braid 3 is shown in Figure 1, it will be understood that there may be more than one. The addition of the braid(s) does not substantially detrimentally affect the bend radius of the cable 2 nor the force required to bend, or flex, the cable 2. However, the strands of copper wire of the cable 2 are held closely together, in other words in contact, by the braid(s) 3 thus enabling the cable 2 to react as a single entity under mechanical loading rather than as individual wires, which does not happen when there is or are no braids. A connector 1 according to the invention thus has an increased flexing load life as compared with prior connectors.

A method for connecting the connector 1 of Figure 1 with an end termination 4 is a two step method (Figures 2 and 3).

The first step, shown in figure 2, is the mechanical swaging or crimping of a tubular metal sleeve 5 onto the end of the electrical connector 1.

Generous radii are allowed in the sleeve 5 at the swage diameter (A) and at the connector 1 outside

diameter (B) such that a rapid change in section of the connector wires, which is a prime cause of metal fatigue, is avoided. It can further be seen that the swage diameter (C) is just above the diameter whereby all of the individual wires of the connector 1 are compressed into a solid copper rod. This swage diameter (C) ensures that the electrical joint or connector is as good as possible without overstressing the individual wires at the radius (A).

At the connector end of the sleeve 5, the sleeve 5 is belled out (D) to allow for flexing of the connector 1, with the belling out being equal to or slightly more than the minimum bend radius of the connector. This belling out further increases the flexing life of the connector 1.

The second step, shown in Figure 3 is connecting the sleeve with the electrical termination 4 selected, in the case a metal one with a socket 6 in which the sleeve is inserted.

The sleeve 5 swaged on the connector 1 is inserted into the socket 6 (Figure 3) with the joint between the sleeve 5 and socket of the end termination 4 being made either by soldering, or by mechanical swaging of the termination.

The advantage of soldering is the "sureness" of the joint and that the termination 4 can be made from any solderable mterial.

The advantage of swaging of this joint is that heat is not required thus eliminating any possible heat problem.

When swaging is used, it will be understood that the metal of end termination 4 should be sufficiently malleable to be mechanically deformed without cracking, or subsequently being liable to fatigue failure.

CLAIMS

1. An electrical connector comprising a plurality of individual strands of electrically conductive metal wire laid up in a desired configuration to form a cable and an outer sheath of metal wire which holds the strands of the cable closely together while allowing the cable to flex under an imposed load.

2. Electrical connector according to Claim 1, the desired configuration comprising a rope-lay configuration.

3. An electrical connector according to Claim 1 or Claim 2, in which the sheath is a braid of woven wires.

4. An electrical connector according to any preceding Claim, in which the individual wires of the cable and the individual wires of the sheath each have substantially the same diameter.

5. An electrical connector according to any preceding claim, the metal wire of the cable and of the sheath being copper wire.

6. An electrical connector, substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

7. A method of terminating an electrical connector according to any preceding claim, comprising the steps of securing a sleeve mechanically to the connector at the end to be terminated without the use of heat, and then connecting the sleeve with the cable secured to it to an end termination.

8. A method according to Claim 7, the step of securing the sleeve and connector being by swaging.

9. A method according to Claim 7 or Claim 8, the step of connecting the sleeve with the end termination comprising inserting the sleeve in a socket of the end termination, and then securing the sleeve and end termination together by use of solder or the like.

10. A method according to Claim 7 of Claim 8, the step of connecting the sleeve with the end termination comprising inserting the sleeve in a socket of the end termination, and then securing the sleeve and end termination together by swaging.

11. A method of terminating an electrical connector according to Claim 1, substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

12. A welding head including an electrical connector according to any of Claims 1 to 6 or terminated using a method according to any one of Claims 7 to 11.

13. A welding head according to Claim 12, which is a robot welding head.

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